Physics 101.

Lecture 26.

Wed. March 12, 2003.

Review for Midterm # 2.

1. Rotational Motion
2. Statics.
3. Simple Harmonic Motion.
4. Waves.

1. Rotational Motion.

- Kinematics $\quad \omega = \lim_{\Delta t \to 0} \frac{\Delta\theta}{\Delta t}$.

$$\alpha = \lim_{\Delta t \to 0} \frac{\Delta\omega}{\Delta t}.$$

$\theta(t)$

$\omega(t)$

$\alpha(t)$

slope $\Downarrow$ $\qquad$ area $\Uparrow$

$s = r \cdot \Delta\theta$. (θ — radians)

$v = r \cdot \omega$.

$a_c = \frac{v^2}{r} = r \cdot \omega^2$.

$a_t = r \cdot \alpha$.

$\vec{a} = \vec{a}_c + \vec{a}_t$

- Dynamics.

$$\tau = \frac{\Delta L}{\Delta t} = I \cdot \alpha .$$

τ — not torque

I — moment of inertia

α — angular acceleration

L — angular momentum.

Many-body systems. $\Sigma \tau_{in} = 0$.

$$\tau_{ext} = \frac{\Delta L}{\Delta t} .$$

- conservation of angular momentum.

when $\tau_{ext} = 0$.

$\Delta L = 0$, $L = \text{const}$. $L_f = L_i$.

- statics.

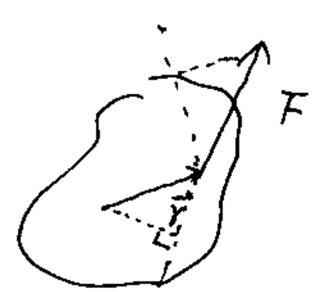
when $\alpha = 0$, $\vec{a} = 0$. $(\vec{a}_{c.m} = 0)$

Then $\Sigma \tau = 0$, $\Sigma \vec{F} = 0$.

choose an "axis of rotation" so that many unknown forces have no contribution to τ.

- The torque of a force.

$$\tau = F \cdot r \cdot \sin\theta = \begin{cases} F \cdot r_{\perp} \\ \text{OR.} \\ F_t \cdot r . \end{cases}$$



- Simple Harmonic Motion.

  characteristic equation: $a = -\omega^2 x$.

  $(\alpha = -\omega^2 \theta)$.

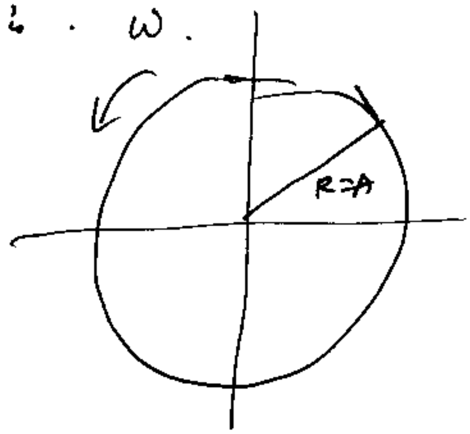
  displacement: $x = A \cdot \cos(\omega t + \varphi)$

  velocity: $v = -\omega A \cdot \sin(\omega t + \varphi)$

  acceleration: $a = -\omega^2 A \cdot \cos(\omega t + \varphi)$

- Reference circle:

  SHM can be described by the x-component of a uniform circular motion. ω.



  $x_{max} = A$.

  $v_{max} = \omega A$

  $a_{max} = \omega^2 A$.

- A, ω, φ.

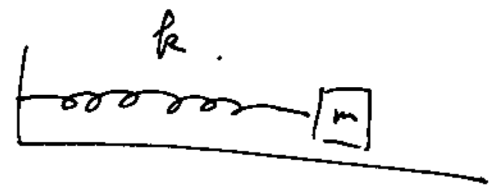
  A — amplitude.

  ω — angular frequency. $T = \frac{2\pi}{\omega}$, $f = \frac{\omega}{2\pi}$.

  φ — initial phase.

  ~~A, φ, —— can be determin~~

- Vibrating block.



$$F = ma.$$

$$-kx = ma.$$

$$a = -\frac{k}{m}x. \qquad (a = -\omega^2 x).$$

$$\omega = \sqrt{\frac{k}{m}}.$$

- Simple pendulum.

$$\omega = \sqrt{\frac{g}{l}}$$

- Waves, — propagation of SHM.

$$y = A\cdot\cos(kx - \omega t + \varphi).$$

$$= A\cdot\cos\left[k(x - vt) + \varphi\right].$$

$$k\cdot v = \omega.$$

$$k = \frac{2\pi}{\lambda}. \qquad \omega = \frac{2\pi}{T}. \qquad v \text{ — speed of wave.}$$

$$v = \frac{\lambda}{T} = \lambda f.$$

- Intensity and Intensity level of sound.

intensity. $I = \frac{P}{A}$.

I — intensity $\cancel{E=P}$ $P = E/t$.

P — power

A — area.

intensity level:

$$\beta = 10 \log\left(\frac{I}{I_0}\right).$$

$I_0 = 1 \times 10^{-12}\ W/m^2$. (Threshold).

in dB.

- Doppler effect.

$$f' = f\left(\frac{1 \pm \frac{u_0}{v}}{1 \mp \frac{u_s}{v}}\right)$$

sign: approaching, f' shifts to higher freq.

receding, f' shifts to lower.

- Superposition principle.

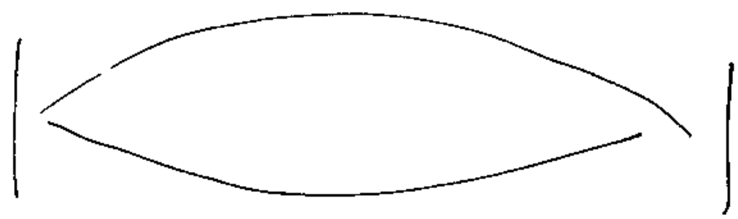
$$y = y_1 + y_2.$$

- Beats.

$$\lambda_B = \text{common multiple of } \lambda_1 \text{ and } \lambda_2.$$

$$f_B = |f_1 - f_2|$$

- standing waves.



$$L = \frac{\lambda}{2}(n).$$

$$\lambda = \frac{2L}{n}.$$

$$f = \frac{v}{2L}\cdot(n).$$

$n=1$ — fundamental

$n=2$ — 2nd harmonic.

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